BASIC ELECTRICITY AND ELECTRONICS

STUDENT HANDOUT NO. 201

SUMMARIES PROGRESS CHECKS FOR MODULES

20 LESSONS 1-5

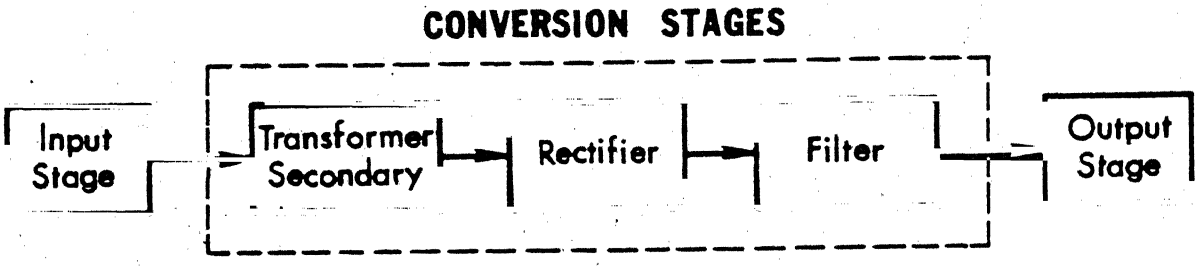
JUNE 1984

U.S. NAVY NAVAL TECHNICAL TRAINING

SUMMARY
LESSON I

Power Supply Functional Analysis

A Power Supply provides all voltages and currents required by a power consuming device or electronic equipment. This function of a power supply is accomplished by combining the individual functions of each of five stages as shown in the block diagram.



The input stage is a circuit accomplishing four functions:

1. Couples the AC voltage from the source to the first conversion stage.
2. Provides overload protection.
3. Indicates power on.
4. Enables the power supply to be turned on or off.

The first conversion stage consists of the secondary of a transformer which steps-up or steps-down the AC voltage from the input circuit. The AC voltage from the transformer secondary is connected to the second conversion stage which rectifies the AC into pulsating DC voltage. The pulsating DC voltage is then sent to the third conversion stage which consists of a filter circuit to suppress the pulsations in the DC voltage.

The filtered DC is then coupled to the output stage where a regulator circuit is frequently used to hold the DC output at a constant level. This DC output can now be coupled to the electronic equipment.

IS POINT, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOU ANSWER ALL TEST ITEMS CORRECTLY, PROCEED TO THE NEXT LESSON. IF YOU FEEL THAT AVE FAILED TO UNDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

PROGRESS CHECK
LESSON 1

Power Supply Functional Analysis

1. The function of a power supply is to supply the correct _____ and _____ for electronic equipment.

2. Four typical functions of the input stage of a power supply are

   a. overload protection, rectification, regulation, on/off indication.
   b. power "on" indication, overload protection, regulation, couple the line voltage to the power supply.
   c. rectification, filtering, regulation, on/off switching.
   d. overload protection, power "on" indication, couple line voltage to the power supply, on/off switching.

3. State the function of the transformer secondary stage of a power supply:

_____

4. The rectifier stage of a power supply converts _____ voltage to pulsating _____ voltage.

5. The function of the filter in a power supply is to

   a. pass high frequencies and block low frequencies.
   b. smooth pulsating DC into a smoother DC.
   c. convert AC to DC voltage.
   d. pass the AC voltage to the regulator.

6. State the two functions of the voltage regulator stage in a power supply:

   a. _____

   b. _____

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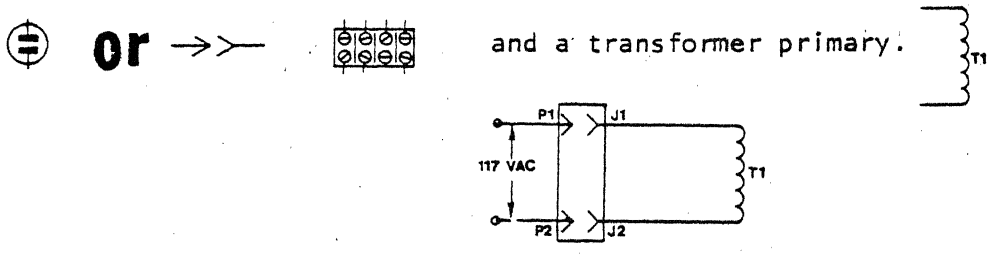
SUMMARY
LESSON II

Power Supply Input Stage

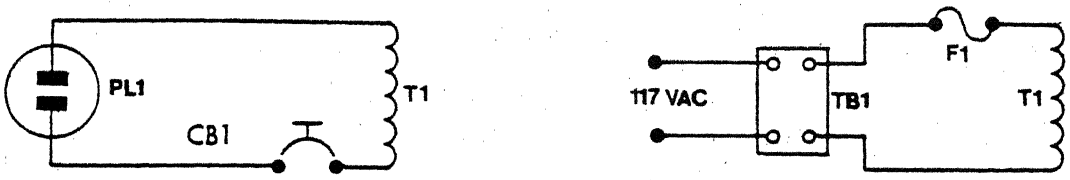
The power supply input circuit is used to:

1. couple AC line voltage to the next stage;
2. protect the circuit from excessive current flow;
3. indicate when AC voltage is on;
4. provide a means of turning the power supply on or off.

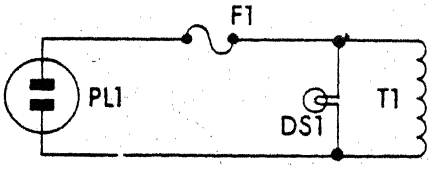
The first function (coupling) is accomplished by using a plug or power connectors.



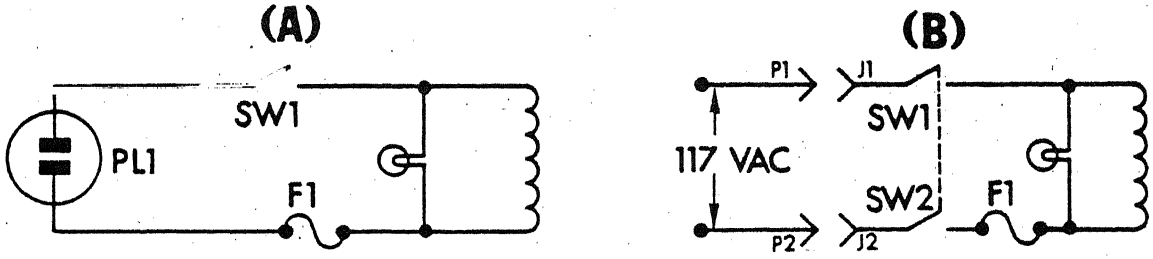
The second function (overload protection) is accomplished by using either a circuit breaker ( ) or fuse ( ) If excessive current is drawn by the equipment, the overload protection components will open and stop current flow in the input circuit.



The third function (power on indication) is accomplished by a lamp or light bulb across the primary of a transformer. When current flows in the input circuit, the lamp will light.



The fourth function is to turn power on or off. This is accomplished by means of a switch.



Example (B) is a "ganged" switch. The dotted line indicates that both contacts will move together.

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JOB PROGRAM
FOR
LESSON II

INPUT STAGE

EQUIPMENT AND MATERIALS

1. Parts Identification Board

PROCEDURE

Locate the Parts Identification Board in your learning center. Take this book with you and complete the exercise. You should be looking at the Parts Identification Board.

1. Match the names listed below to the components numbered from 1 to 25 on the Parts Identification Board.

(NOTE: Skip numbers 4, 7, 9, 14, 18 and 24)

a. Terminal Board
b. Switch
c. Fuse
d. Indicator light
e. Transformer
f. Circuit breaker
g. Wall plug
h. Multiple Connector
i. Fuse holder

Component #		Component #	
1.	_____	15.	_____
2.	_____	16.	_____
3.	_____	17.	_____
5.	_____	19.	_____
6.	_____	20.	_____
8.	_____	21.	_____
10.	_____	22.	_____
11.	_____	23.	_____
12.	_____	25.	_____
13.	_____		

2. Draw the schematic symbols for each component.

a. Terminal board

b. Switch

c. Fuse

d. Indicator light

e. Transformer

f. Circuit breaker

g. Wall plug

h. Multiple connector

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PROGRESS CHECK
LESSON 11

Power Supply Input Stage

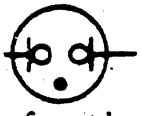
1. State the function of Power Connectors.

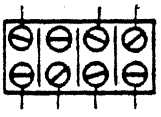
_____

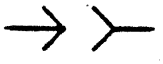
2. Place a check mark beside the symbol(s) used for power connectors.

____a. 

____b. 

____c. 

____d. 

____e. 

____f. 

3. State the function of circuit breakers.

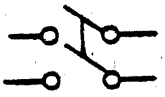
_____

4. Identify by name each of the illustrated symbols.

a.  _____

b.  _____

c.  _____

d.  _____

5. State the function of power switches.

_____

6. State the function of indicator lights.

_____

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SUMMARY
LESSON III

Power Supply Transformer Secondary Stage

The AC voltage supplied from the wall socket is coupled through the input stage to the transformer secondary. The secondary may step-up, step-down, or leave the voltage the same, depending on the turns ratio between the primary and secondary windings. The voltage may need to be increased or decreased because the rest of the power supply requires a different level than is supplied by the external source.

The power supply often requires more than one voltage. Therefore multiple secondaries driven by a single primary may be used. Each secondary winding provides a desired voltage depending on its turns ratio as compared to the primary.

Another commonly used secondary is the center-tapped secondary. The center-tapped secondary splits the total secondary voltage into two equal voltages of opposite polarity.

No matter what amplitude or phase of AC voltage(s) is needed by the power supply, it can be provided by one of these types of secondary windings.

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JOB PROGRAM FOR LESSON III

Power Supply Input and Transformer Secondary Stages

REFERENCES

1. Instruction Manual, Power Supply, NIDA Trainer Model 201
2. Instruction Manual, Load Box, NIDA Trainer Model 201L.

EQUIPMENT AND MATERIALS

1. Oscilloscope
2. Device NIDA 201 Power Supply
3. PC 201-1 Printed Circuit Card
4. Device NIDA 201 Load Box
5. 10X Probe (Tektronix 10X or WG-400 A)
6. Multimeter, and meter leads
7. Double Banana Plug Cable

PROCEDURE

1. Following all applicable safety precautions, energize and obtain a line trace on the oscilloscope. Center the trace on the screen, and make the following settings:

   a. Volts/CM Control - 5 Volts/CM
   b. SWEEP FREQ Hz Control - TV.V
   c. AC - DC - GND Switch - AC
   d. 10X Probe - Connect to IN Jack oscilloscope. (If using the WG-400 A, ensure that the switch on the probe is in the 10X position.)

   NOTE: THROUGHOUT THIS JOB PROGRAM YOU WILL BE DIRECTED TO TAKE READINGS AT VARIOUS TEST POINTS (TP's). IN ALL CASES, IN THIS JOB PROGRAM, YOU ARE TO USE THE TEST POINTS LOCATED ON THE CHASSIS OF THE NIDA 201 POWER SUPPLY AND NOT THE TEST POINTS ON THE PC 201-1 PRINTED CIRCUIT CARD.

2. Following all applicable safety precautions (DO NOT PLUG IN THE POWER SUPPLY CORD YET) set up the NIDA 201 and NIDA 201L training devices as follows:

   a. Remove the top cover of the NIDA 201 Power Supply and insert PC-201-1 (Half-Full Wave) Circuit Card. Place switch S4 (on PC-201-1) in the half-wave position. If the 10X probe has a ground wire, connect the ground wire to pin 1 of PC-201-1. If the 10X probe does not have a ground wire, or existing ground wire is too short, connect an alligator clip lead between pin 1 of PC-201-1 and a ground connection on the oscilloscope.

NOTE: - DO NOT USE CR1 OR CR2 FOR GROUND CONNECTIONS!!

b. Look at both ends of the dual banana plug cable and notice the tabs labeled "GROUND". Insert one of the plugs into the NIDA 201 Power Supply output jacks with the ground side in the ground jack (white) and the other side in the +DC (red) output jack. Connect the other end of the dual banana plug cable to the NIDA 201L Load Box with the side of the plug labeled "GROUND" in the black input jack and the other side of the banana plug in the red input jack.

NOTE: Ensure that a metal strap is connected from the ground terminal to the -DC (black) terminal on the NIDA 201 Power Supply.

Place all three NIDA 201L Load Box switches in the down position and the Selector Switch in the "lamps" position.

c. Plug in the NIDA 201 Power Supply and turn the power switch "ON".
DANGER: There are now bare connections that may have 115VAC on them. There are also several connections that will have DC potentials on them. See Figure 1.

d. Lamps 1 and 3 on the NIDA 201L Load Box should be "on" when the NIDA 201 Power Supply is energized.

e. De-energize the NIDA 201 Power Supply and unplug it's power cord.

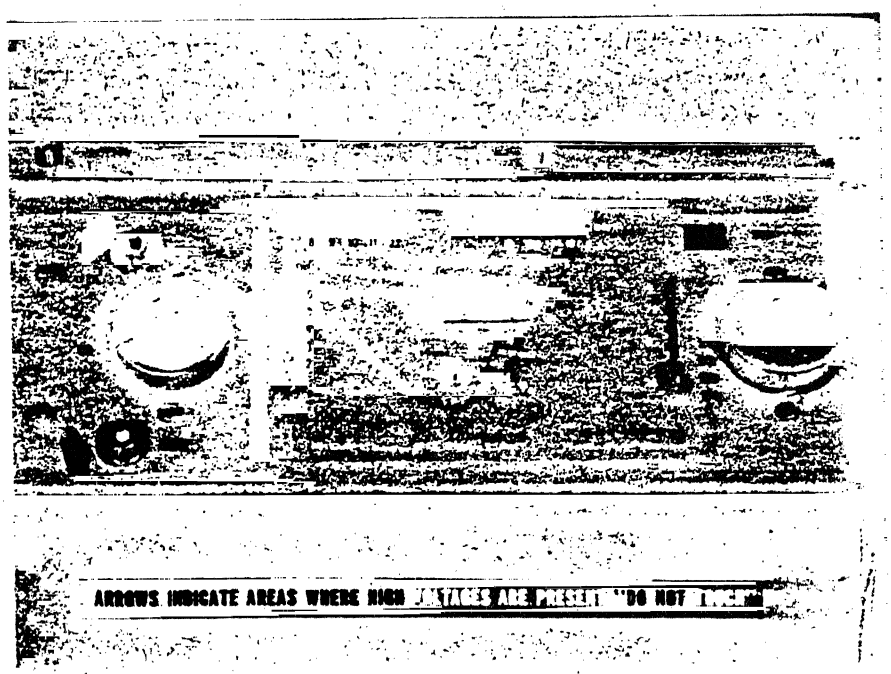

Figure 1. Indicating Areas Where High Voltages Are Present.

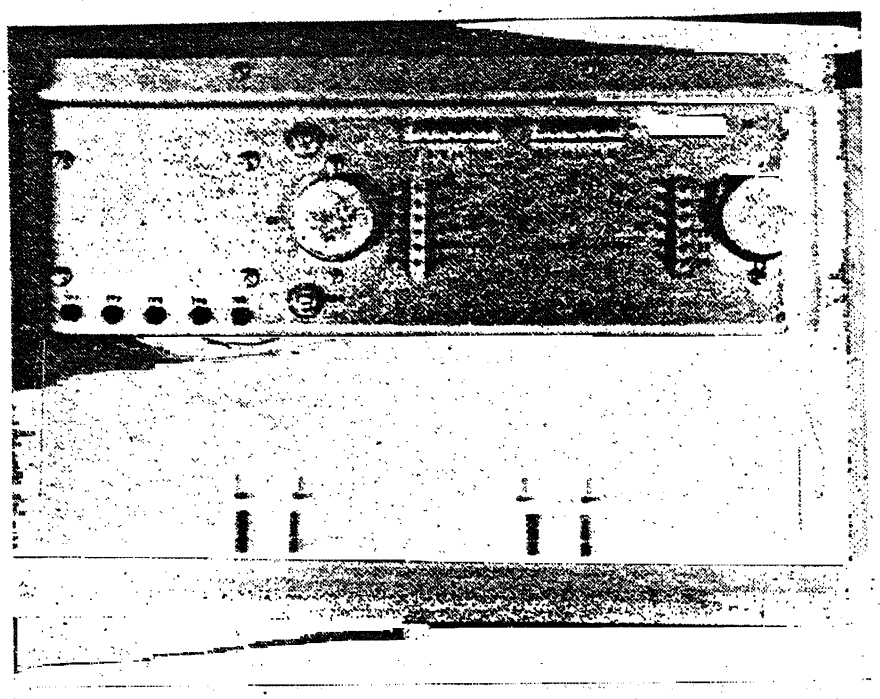

Figure 2. Test Point Locations.

3. a. Locate TP1 on the lower left corner of the Power Supply chassis assembly plate. Place the tip of the oscilloscope probe on TP1. Refer to the schematic diagram (Figure 3) to see where the test points are connected in the Power Supply circuit. Plug in the Power Supply. Calculate and record the peak-to-peak voltage at TP1. TP1 measures _____ volts peak-to-peak.

   b. The peak (+ or -) voltage at TP1 is _____ volts peak.

   c. Calculate the RMS of the voltage measured in Item 3b above _____ VAC (RMS).

   d. Unplug the NIDA 201 Power Supply.

   e. Measure the AC voltage in reference to ground at TP1 with a multimeter. Place the red lead in TP1 and the black lead at Pin-1 on PC-201-1. Plug in the NIDA 201 Power Supply. The multimeter reading at TP1 is _____ volts AC.

   f. Unplug the NIDA 201 Power Supply.

4. On the schematic diagram in Figure 3, locate switch S2. When fuse F1 is installed and the power switch (S1) is turned on, there is an AC voltage present at this terminal. To measure the voltage at this point we would use TP2. Place the tip of the 10X probe in TP2, plug in the NIDA 201 Power Supply, and turn the power switch (S1) on

   a. The peak-to-peak voltage at this point on switch S2 is _____ VAC_{p-p}.

   b. With the NIDA 201 power switch in the "on" position, is there a difference in voltages at switch S2 and the fuse holder? _____ (yes/no).

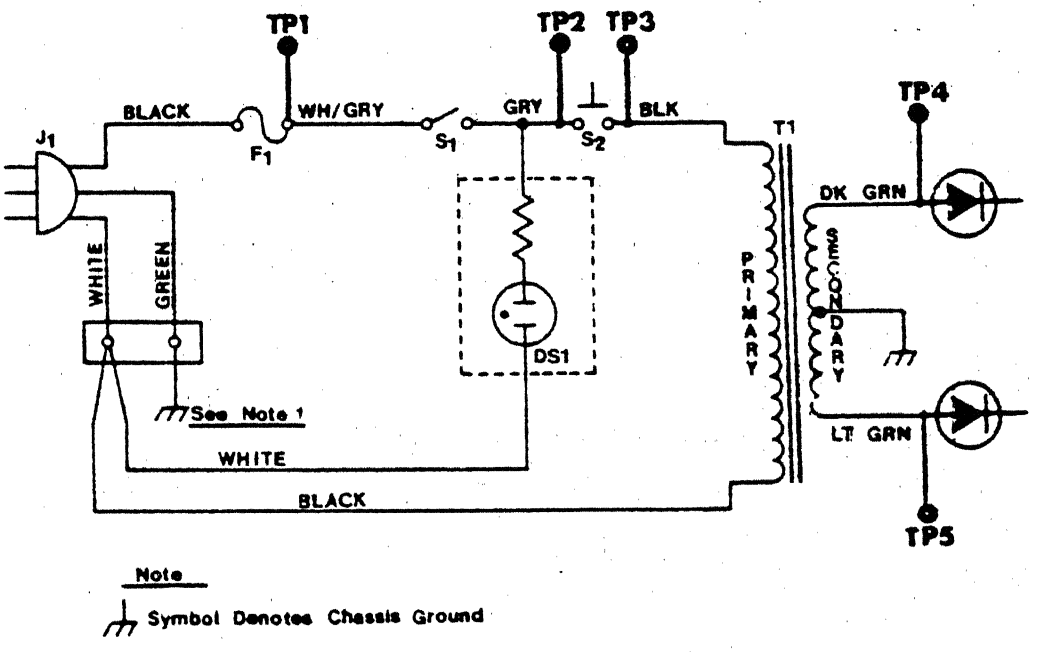

Figure 3. Schematic of Power Supply.

5. Turn the NIDA power switch "off". Is there a difference in the voltage at the fuseholder (TP1) and the voltage at switch S2 (TP2)? _____ (yes/no).

6. a. Place the tip of the 10X probe in TP3. Turn the NIDA 201 Power Supply "on" and observe the waveform and record the peak-to-peak voltage at this test point. The voltage at TP3 is _____ VAC_{p-p}.

   b. TP3 is connected to S2 and _____ .

      (1) the secondary winding of transformer T1.
      (2) the primary winding of transformer T1.
      (3) switch S1.
      (4) lamp DS1.

   c. Turn the power switch "off" and remove PC-201-1 (Half/Full Wave) circuit board. This circuit board is located on top of the NIDA 201 Power Supply chassis plate. Turn the power switch "on" and observe the waveform at test point TP2 (S2). Do you have a waveform at this point? _____ .
      (yes/no)

   d. Turn the NIDA 201 Power Supply switch "off".

   e. Move the 10X probe to the other side of S2 (TP3). Turn the NIDA 201 power switch "on". Do you have a waveform at this point? _____ .
      (yes/no)

7. Switch S2 is a safety switch that opens and removes power to transformer T1 when PC-201-1 printed circuit card is not installed. You will see switches like this used in electronic equipment throughout the Navy. These switches are commonly called "INTERLOCKS".

8. To answer questions 8a and 8b refer to Figure 3 (Schematic of Power Supply).

   a. Will the "Power On" lamp (DS1) glow with fuse F1 open? _____
      (yes/no)

   b. Will the "Power On" lamp (DS1) glow with S2 open? _____
      (yes/no)

   c. Turn the NIDA 201 Power Supply power switch off and unplug the power cord. Remove fuse F1 (located on the back panel of the NIDA 201). Plug in the NIDA 201 Power Supply and turn the power switch on. Check your answer to item 8a.

   d. Turn the power switch off and unplug the NIDA 201 Power Supply. Reinstall the fuse (F1).

   e. Plug in the NIDA 201 Power Supply, and turn the power switch on. Check your answer to item 8b.

   f. Turn the NIDA 201 Power Supply power switch off and reinstall PC-201-1 printed circuit card.

9. Locate TP4 (CR1) and TP5 (CR2).

10. a. Connect the 10X probe to TP5. Turn the NIDA 201 Power Supply power switch "on". Measure and record the voltage at the anode of CR2 (TP5). _____ VAC_{p-p}.

    b. Turn the NIDA 201 power switch "off".

    c. Move the 10X probe from TP5 to TP4. Turn the NIDA 201 power switch "on". Is the voltage at the anode of CR1 (TP4) the same as that in step 10a? _____ .
    (yes/no)

11. Compare the peak-to-peak voltage at diode CR1 (step 10a) to the peak-to-peak voltage you observed in step 3a. Are the voltages the same? _____ .
(yes/no)

12. a. What is the peak-to-peak voltage ratio between the primary (TP 3) and the secondary 1 winding (TP 4) of transformer T1? _____ .

    b. This is a _____ transformer.
    (step-up/step-down)

13. Turn the NIDA 201 power switch off. Unplug the NIDA 201 Power Supply. Replace all equipment covers and return all equipment to its proper stowage.

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PROGRESS CHECK

LESSON III

Power Supply Transformer Secondary Stage

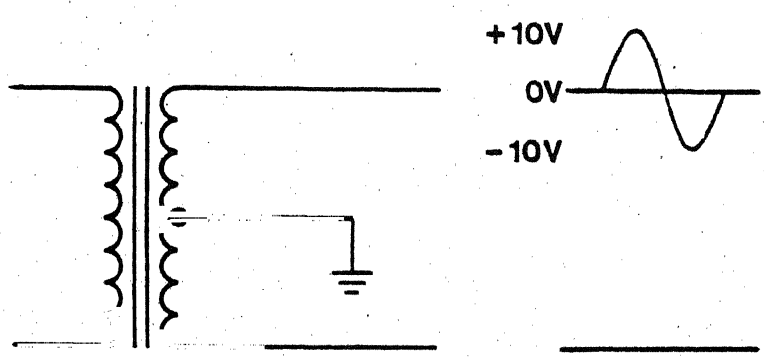
1. Which waveform characteristic(s) will be changed by a step-up or step-down transformer?

   a. Frequency
   b. Voltage
   c. Shape

2. The function of a multi-secondary transformer is to:

   a. provide a single output voltage from two or more input voltages.
   b. provide multiple output voltages from a single input voltage.
   c. increase the power of the input voltage.

3. The diagram below shows the waveform available from one end terminal of a center-tapped transformer secondary. Draw the corresponding cycle of voltage available for the other end terminal.



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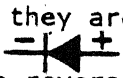
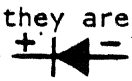
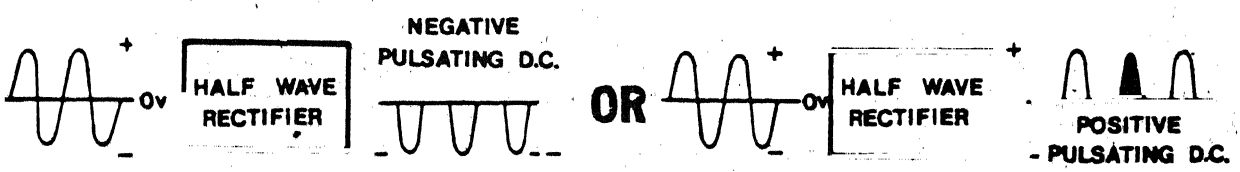
SUMMARY
LESSON IV

Power Supply Rectifiers

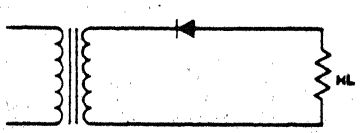
Rectifier circuits are connected to the secondary of a power supply transformer in order to convert AC voltage into DC voltage. Three types of rectifiers are: half-wave, full-wave, and bridge.

Power supply rectifiers utilize diodes for their operation. Diodes conduct when they are forward biased (cathode negative with respect to the anode ) and offer tremendous resistance to current flow when they are reverse biased (cathode positive with respect to the anode ).

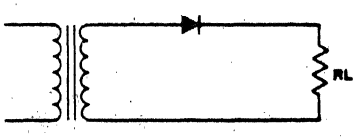
The half-wave rectifier consists of one diode which simply eliminates either the positive or negative alternations of the input AC voltage.



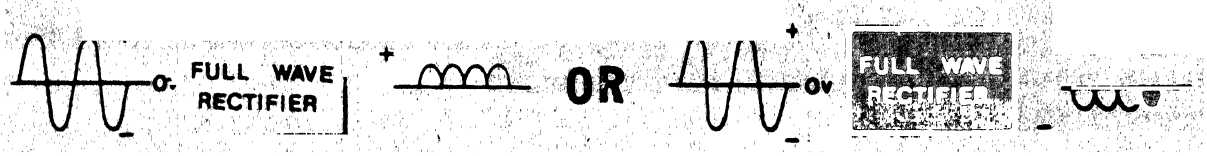
A half-wave rectifier circuit with a negative DC output will contain one diode connected as shown.



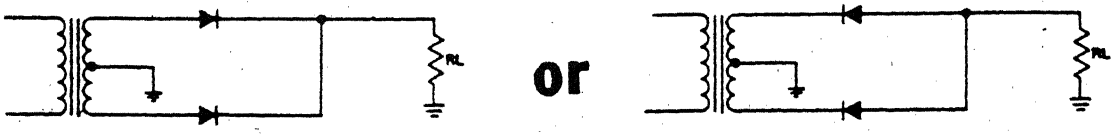
A positive DC output can be obtained with this cicruit:



In order to convert every alternation of the input AC voltage to pulsating DC, a full-wave rectifier is used. The full-wave rectifier converts each alternation of the AC voltage to either positive or negative pulsating DC voltage.



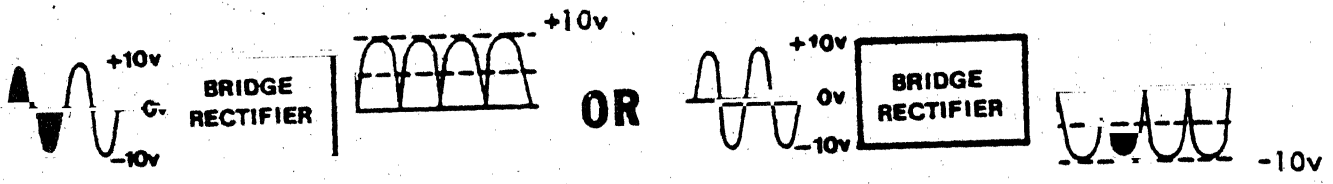
A full-wave rectifier uses two diodes and a center-tapped transformer secondary winding.



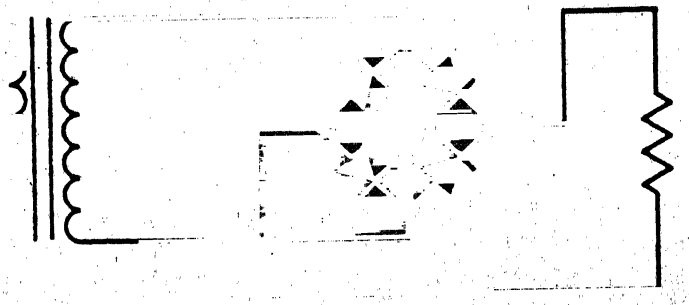
Positive DC Output Negative DC Output

The transformer center-tapped secondary divides the secondary AC voltage into two equal, out-of-phase AC voltages, each of which is half the total secondary voltage. Depending on circuit configuration, the diodes will pass either the positive or negative alternations of the AC input voltage, first from one diode, then from the other. The average output voltage of the full-wave rectifier is the same as the half-wave rectifier, but the variations in the pulsating DC output are less with the full-wave rectifier.

A bridge rectifier also converts each alternation of the input AC voltage to the same DC polarity at the output, but, with the same secondary voltages, the peak amplitude of the DC voltage is twice that of the full-wave.



The circuit for a bridge rectifier requires (4) diodes.



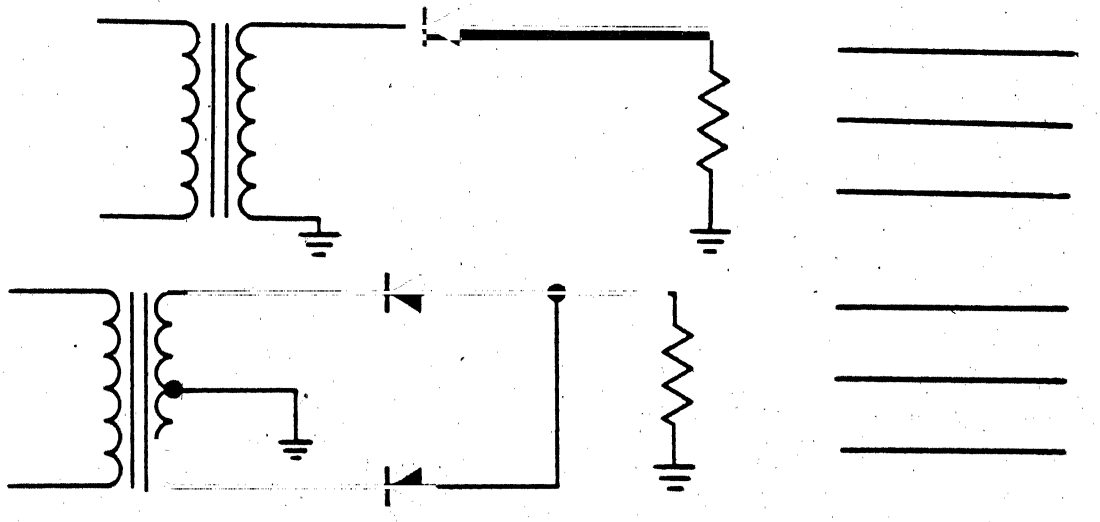
AT THIS POINT, YOU MAY PROCEED TO THE JOB PROGRAM. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU UNDERSTAND THE MATERIAL IN THIS LESSON.

A V RESPONSE SHEET
LESSON IV

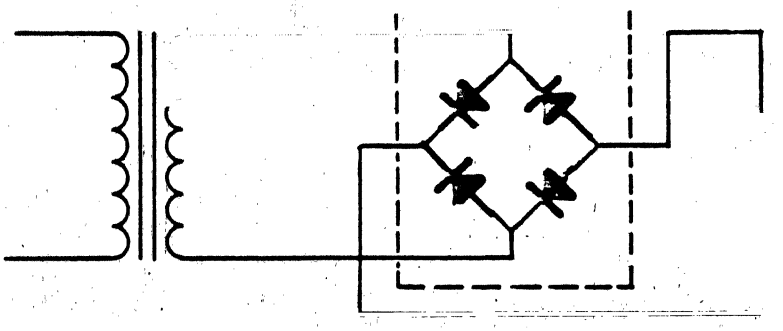
Power Supply rectifiers

ANSWER THE QUESTIONS IN STATIC/MOTION PROGRAM TWENTY-IV ON THIS RESPONSE SHEET.

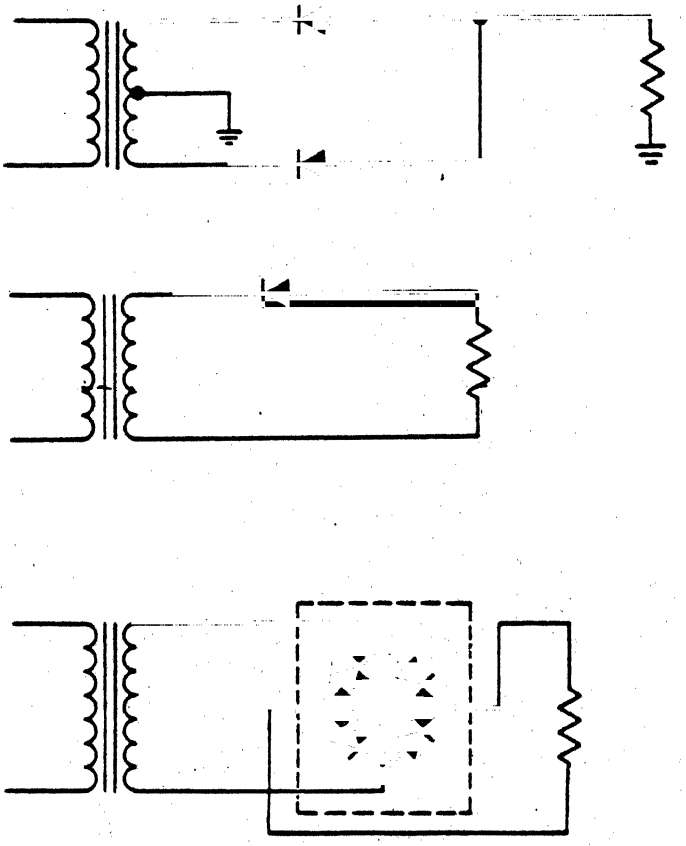
1. Draw the output waveforms and amplitudes for the two circuits shown.



2. Trace current flow in the bridge circuit below.



3. Label each rectifier circuit below, with its proper name (half-wave, etc.) and output polarity (positive or negative).



JOB PROGRAM
FOR
LESSON IV

Power Supply Rectifiers

INTRODUCTION

One measure of the condition of a diode is called the front-to-back ratio. As you know, diodes are special devices that allow current to flow in only one direction. Actually, a more realistic statement is that current flows easily in one direction, but with great difficulty in the other. It's like a waterfall: water flows down the waterfall very easily; it is possible to make the water go up the waterfall, but it isn't easy.

According to Ohm's Law (and our practical experience) current flows easily if the resistance is low, and current flow is very limited if the resistance is high. A diode is a device that acts like a high resistance to current flow in one direction and a very low resistance to current flow in the other direction. An ohmmeter can be used to measure this difference in resistance. The ratio of the effective resistance in one direction to the effective resistance in the other direction is called the front-to-back ratio. The ratio is written:

$$\frac{\text{low resistance}}{\text{low resistance}} : \frac{\text{high resistance}}{\text{low resistance}}$$

The leads of an ohmmeter are polarized; i.e., one lead is connected to the positive terminal of an internal battery, and the other is connected to the negative terminal of the internal battery. In most ohmmeters the black lead is negative, the red lead positive. When an ohmmeter is used to measure resistance, the internal battery tends to cause electrons to flow from the negative meter lead through the resistance to the positive meter lead. The amount of current flow is inversely proportional to the resistance, and the meter face is calibrated in ohms. An ordinary resistor will show the same amount of resistance no matter what direction the current is flowing (meter leads reversed) but a "good" diode will show a low resistance when the leads are applied one way and a high resistance when the leads are reversed.

As an example a given diode may measure 10,000 ohms with black lead to anode, red lead to cathode (reverse bias) and 10 ohms with the leads reversed. The front to back ratio of this diode is 10,000:10 (read as ten thousand to ten) or, reducing to lowest terms, 1,000:1. This is occasionally written in the form $\frac{10,000}{10}$ and, reducing, $\frac{1,000}{1}$. It is spoken the same way in either case. A common rule of thumb is that a good diode will have greater than 10:1 front to back ratio.

EQUIPMENT AND MATERIALS

1. Multimeter
2. Parts Identification Board

PROCEDURE

Now is the time for you to measure some front-to-back ratios. Go to the parts identification board, and when you get there:

a. Set the multimeter to measure resistance in the R X 100 scale,
b. Measure and record the resistance of each diode in one direction,
c. Now, reverse the meter leads and measure and record the resistance of each diode in the other direction.

Component #26 Low reading _____, High reading _____.
Component #27 Low reading _____, High reading _____.
Component #28 Low reading _____, High reading _____.
Component #29 Low reading _____, High reading _____.

Calculate the front-to-back ratios:

Record the front-to-back ratios:

Component #26 _____ #27 _____ #28 _____ #29 _____

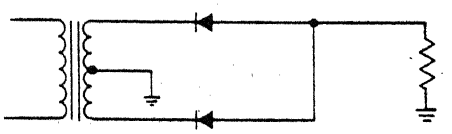
Are all of the diodes "good"? _____ (yes/no)

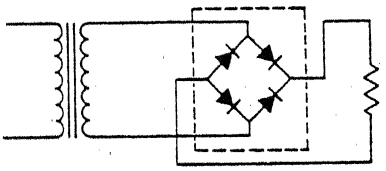
CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST; OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

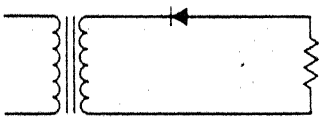
PROGRESS CHECK
LESSON IV

Power Supply Rectifiers

1. Write the name of each of the illustrated rectifier circuits in the space provided.







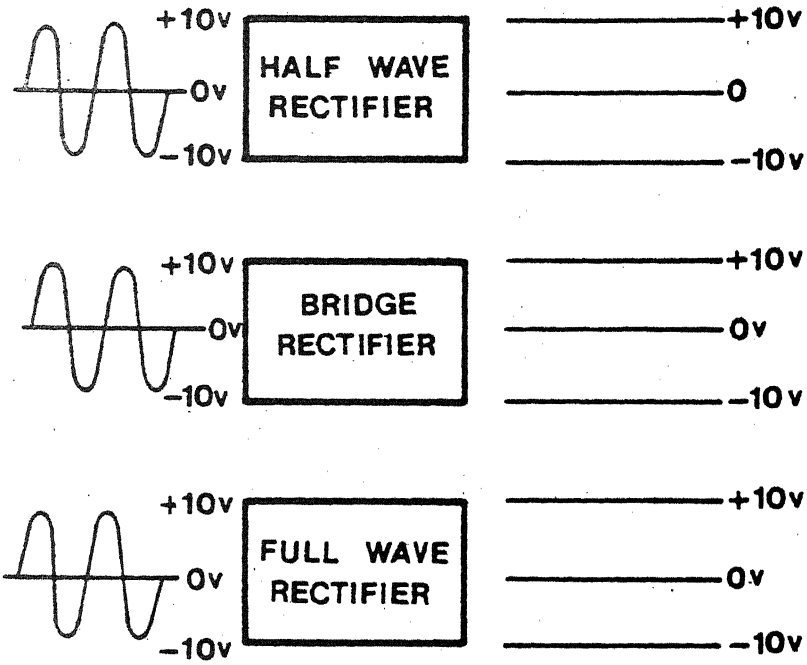
2. One advantage of full-wave rectifier over a half-wave rectifier is

   a. fewer components.
   b. less voltage variation in the DC output.
   c. higher voltage level for the same transformer secondary voltage.

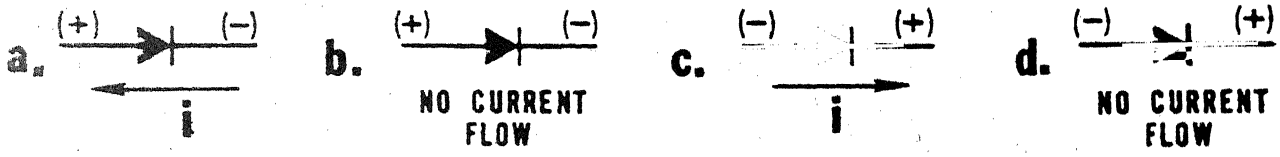
3. For the same total voltage across the transformer secondary winding, the bridge rectifier will have

   a. twice the DC output voltage as a full-wave rectifier.
   b. half the DC output voltage as a full-wave rectifier.
   c. the same DC output voltage as a full-wave rectifier.

4. Draw the output waveforms for each of these circuits (assume a positive DC output).



Use the illustrations below to answer questions 5 and 6.



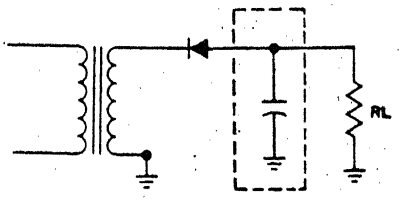
5. Which illustration correctly represents a forward biased diode?_____

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE NEXT LESSON. IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

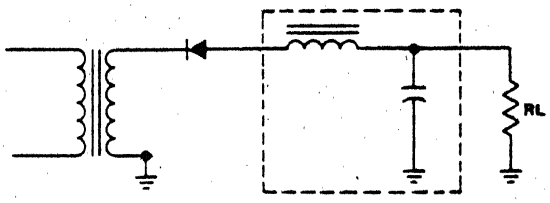
SUMMARY
LESSON V

Filter Section

Filter circuits used in power supplies are of two general types; capacitor input

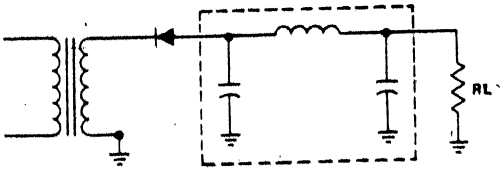


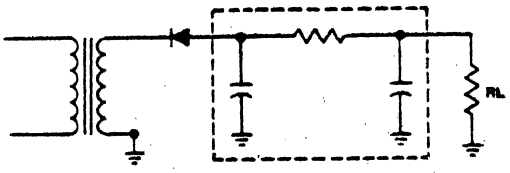
and choke input.



The filter's sole purpose is to remove the pulsations from the rectifier output to produce a smooth DC voltage.

The Capacitor Input Filter produces a smooth, steady DC voltage by opposing any change in voltage. The Choke Input Filter accomplishes the same thing by opposing any change in current. A happy median is reached by combining the two filters and creating a pi filter. The pi filter is a capacitor input filter that may have either a coil or a resistor separating a pair of capacitors is parallel.





The pi configuration using the coil is the most common one used in electronics. It can provide high voltage and high current. The pi filter gets its name from its schematic configuration which is usually drawn to resemble the Greek letter pi (π).

AT THIS POINT, YOU MAY PROCEED TO THE JOB PROGRAM. IF YOU FEEL THAT YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU UNDERSTAND THE MATERIAL IN THIS LESSON.

A-V RESPONSE SHEET
LESSON V

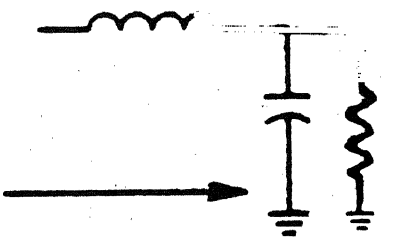
Power Supply Filters

ANSWER THE QUESTIONS IN STATIC/MOTION PROGRAM TWENTY-V ON THIS RESPONSE SHEET.

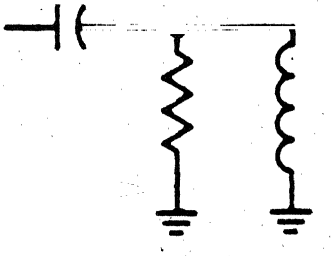
1. _____

_____

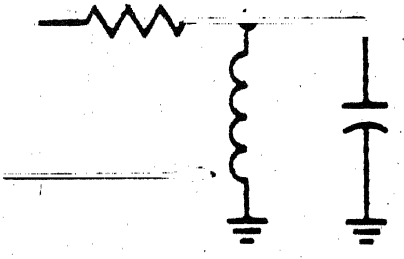
2. a.



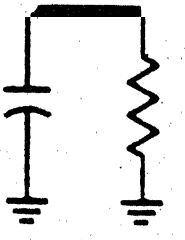
b.



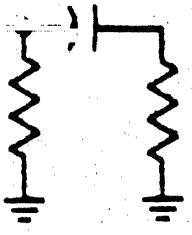
c.



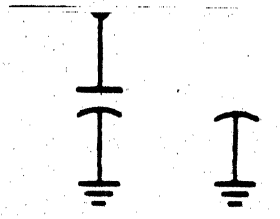
d.



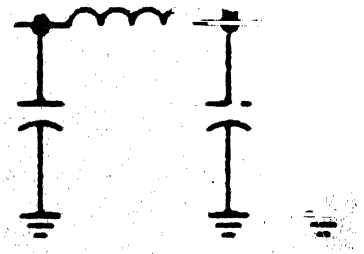
3. a.



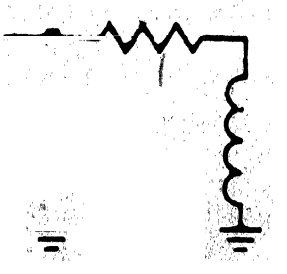
b.



c.



d.



JOB PROGRAM
FOR
LESSON V

Power Supply Rectifiers and Filters

EQUIPMENT AND MATERIALS

1. Oscilloscope
2. NIDA 201 Power Supply
3. NIDA 201L Load Box
4. PC 201-1 Printed Circuit Card
5. Dual Banana Plug Cable
6. 10X Probe
7. Jumper Wire (Alligator Clip on each end)

PROCEDURE

1. Connect the Load Box to the NIDA 201 Power Supply with the Dual Banana Plug Cable. On the Load Box set the LOAD SELECTOR switch to "lamps" and place all toggle switches to the "down" position.

2. Energize and obtain a line trace on the oscilloscope, and make the following settings:

    a. VOLTS/CM - 2 volts/cm
    b. SWEEP FREQ Hz - - tv.v
    c. AC-DC-GND - DC
    d. Connect 10X Probe to the IN Jack on the oscilloscope.

    NOTE: FOR THIS JOB PROGRAM YOU WILL USE TP's 1 AND 2 LOCATED ON PC 201-1 PRINTED CIRCUIT CARD AND NOT THE TP's ON THE POWER SUPPLY CHASSIS.

3a. With the Power Supply right side up, remove the top cover and insert PC 201-1 (Half - Full Wave Printed Circuit Card).

3b. Place the HALF WAVE - FULL WAVE Switch, S4, on PC 201-1 in the "Half Wave" position.

3c. Place the 10X Probe on TP1 with the probe ground on any convenient chassis ground.

IMPORTANT! DO NOT GROUND THE PROBE TO CR1 OR CR2

3d. Ensure all connections are properly made.

Now, let's add the rectifier schematic to the schematic of the input transformer secondary we worked with in Figure 3 of the job program for Lesson III.

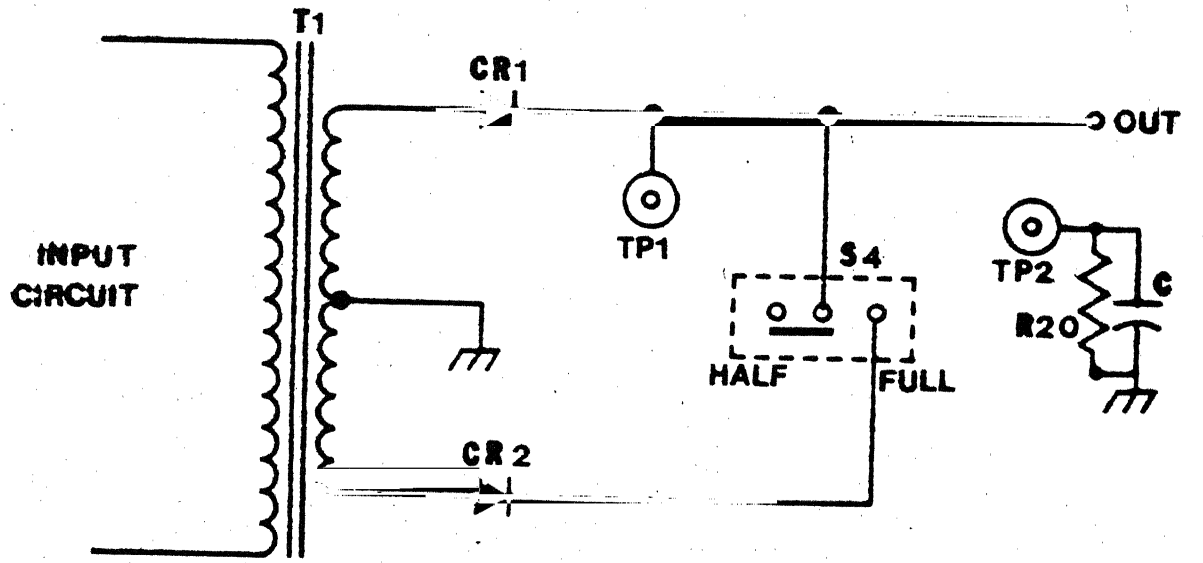


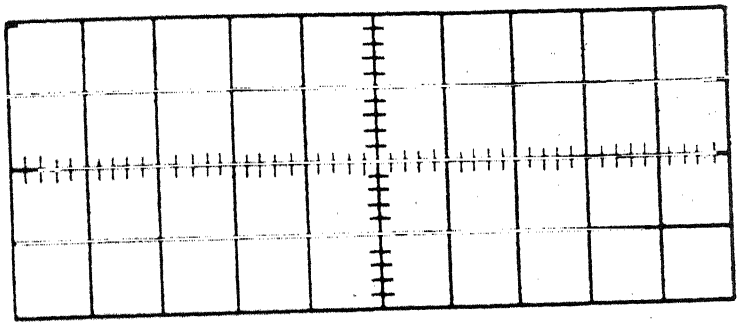
Figure 1

4. The output of the rectifier circuit is from TP1 on circuit board PC 201-1 (Half - Full wave Rectifier). Switch S4 gives us the capability of examining the output from either a half wave or a full wave rectifier. Refer to Figure 1.

5. With S4 in the half wave position, we use diode _____ .

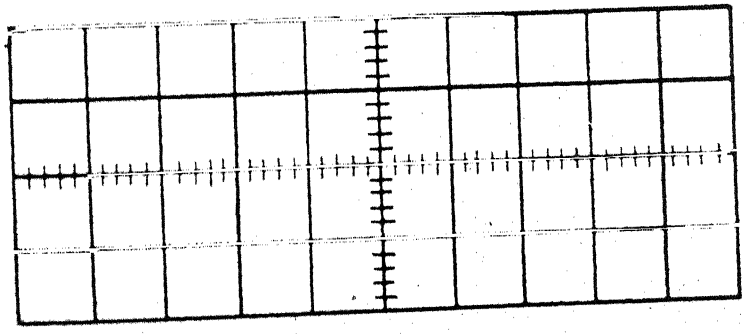
(1) CR1 only
(2) CR2 only
(3) CR1 and CR2

6. Energize the NIDA 201 Power Supply and observe and draw the waveform at TP1 on PC 201-1.



_____ $V_{p-p} \pm 10\%$

7 a. Place the HALF - FULL WAVE Switch (S4) on PC 201-1 in the "FULL WAVE" position. Observe and draw the waveform at TP1 on PC 201-1.



_____ $V_{p-p} \pm 10\%$

Answer the following question.

The full wave rectifier output voltage uses:

(1) only the positive alternation of the AC input.
(2) only the negative alternation of the AC input.
(3) both the positive and negative alternation of the AC input.

7 c. The full wave rectifier output has (half as many/twice as many/ the same number of) pulses per cycle as the half wave rectifier output.

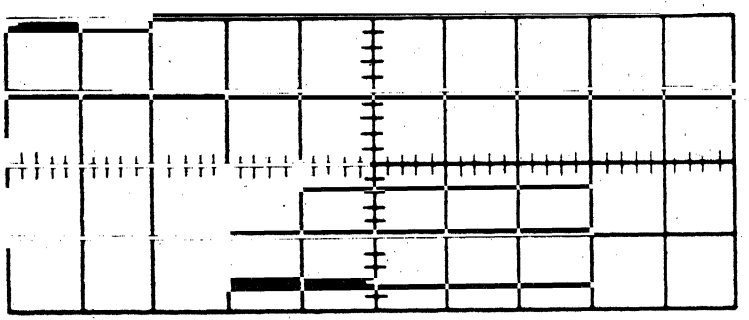
8. Record the voltage and current readings from the meters on the front of the Power Supply.

_____ VDC _____ DC AMPS

9. Notice that the meter on the front of the NIDA 201 doesn't indicate the pulsations (known as ripple) that can be seen on the oscilloscope.

10. Turn off the Power Supply and install a jumper between TP1 and TP2 on PC 201-1 then reenergize the Power Supply.

11. Measure and record the voltage and waveform at TP1 on PC 201-1.



_____ VDC

12. Record the voltage and current readings from the meters on the front of the Power Supply.

_____ VDC _____ DC AMPS

By adding the jumper between TP1 and TP2 (on PC 201-1) you added capacitor C1 to the circuit. (Refer to Figure 2-3 in the NIDA 201 Instruction Manual.) Inserting capacitor C1 into the circuit caused the ripple to _____ and the voltage to _____

13. While observing the oscilloscope presentation, turn the Power Supply off. Notice that the voltage at TP1 "bleeds" off slowly. <u>This is a very important point to remember</u>. Turning a power supply switch off does not guarantee that you can safely touch the conducting surfaces. Capacitors are capable of storing enough energy to <u>K I L L</u> you long after the circuit has been deenergized. <u>All capacitors must be discharged before you can assume that it is safe to touch conducting surfaces</u>!!! The approved method for doing this is to short each capacitor's positive and negative leads together through a jumper wire. In high voltage circuits it is best to use a low-resistance, high-wattage resistor in series with a jumper. However, when using the NIDA 201 Power Supply, a standard jumper will suffice.

14. With the Power Supply deenergized, obtain a jumper and short TP2 on PC 201-1 ground.

Referring to Figure 2-3 in the NIDA Instruction Manual, which side of C1 (positive/negative) have you jumpered to ground?

15. De-energize and return all equipment to its proper stowage.

CHECK YOUR RESPONSES TO THIS JOB PROGRAM WITH THE ANSWER SHEET. IF YOUR RESPONSES AGREE WITH THE ANSWER SHEET, YOU MAY TAKE THE LESSON PROGRESS CHECK. IF YOUR RESPONSES DO NOT AGREE OR IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THIS JOB PROGRAM, REVIEW THE PROCEDURES OF THIS JOB PROGRAM, ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR UNTIL YOUR RESPONSES DO AGREE.

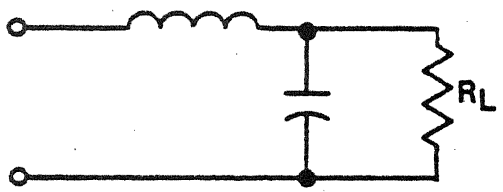
PROGRESS CHECK
LESSON V

Power Supply Filters

1. The purpose of a power supply filter is to:

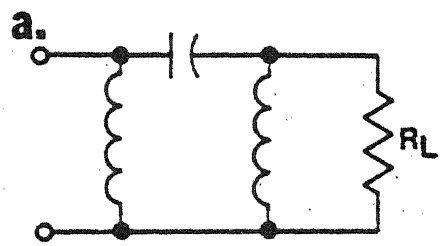
   a. convert AC to DC voltage.
   b. smooth the DC voltage.
   c. maintain the DC voltage at a constant level.
   d. supply the proper AC voltage for equipment operation.

2. The illustrated filter circuit can be classified as a _____ input filter.

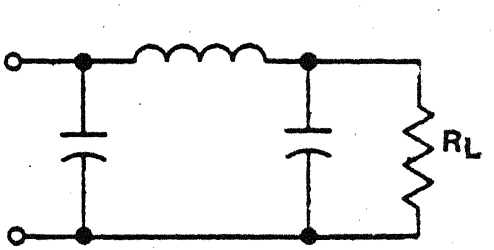


3. Select the correct schematic for a pi filter circuit:

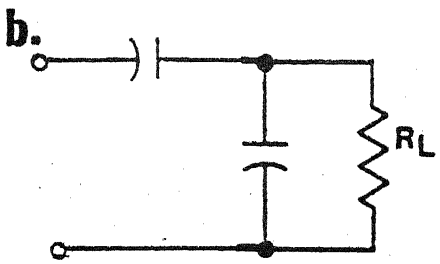
a.



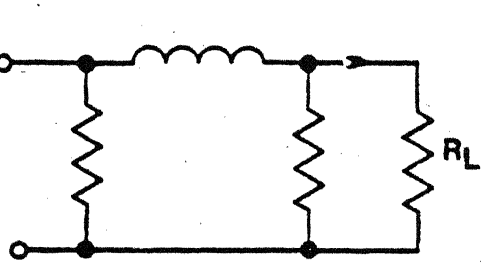
c.



b.



d.



4. Which of the above schematics is a capacitor input filter?

CHECK YOUR RESPONSES TO THIS PROGRESS CHECK WITH THE ANSWER SHEET. IF YOU ANSWER ALL SELF-TEST ITEMS CORRECTLY, PROCEED TO THE NEXT LESSON. IF YOU FEEL YOU HAVE FAILED TO UNDERSTAND ALL, OR MOST, OF THE LESSON, SELECT AND USE ANOTHER WRITTEN MEDIUM OF INSTRUCTION, AUDIO/VISUAL MATERIALS (IF APPLICABLE), OR CONSULTATION WITH YOUR LEARNING CENTER INSTRUCTOR, UNTIL YOU CAN ANSWER ALL SELF-TEST ITEMS ON THE PROGRESS CHECK CORRECTLY.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON 1

Power Supply Functional Analysis

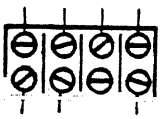
QUESTION NO.	CORRECT ANSWER
1	Voltage, current (either order)
2	d
3	Step the input up or down
4	AC, DC
5	b
6a	Regulates the output (maintains constant output voltage)
6b	Couple output to electronic equipment (load)

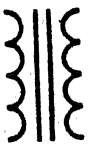
ANSWER SHEET
FOR
JOB PROGRAM
LESSON II

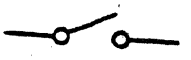
Input Stage

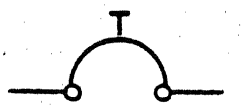
1.

1. g
2. e
3. c
5. d
6. f
8. i
10. b
11. a
12. h
13. b
15. I
16. a
17. b
19. c
20. b
21. h
22. e
23. i
25. h

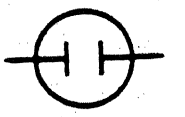
2. a. 

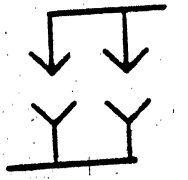
e. 

b. 

f. 

c. 

g. 

h. 

ANSWER SHEET FOR PROGRESS CHECKS LESSON II

Power Supply Input Stage

QUESTION NO.	CORRECT ANSWER
1	Connect ship's supply into power supply
2	a, d, e
3	Provide overload protection
4a	Circuit breaker
4b	Indicator lamp
4c	Fuse
4d	Switch
5	Turn power supply on or off
6	Indicate power on condition

ANSWER SHEET
FOR
JOB PROGRAM
LESSON III

Input and Transformer Secondary Stages

3a. 340 Vp-p ± 10%

3b. 170 v ± 10%

3c. 120 VRMS ± 10% (Remember: RMS voltage is .707 times peak voltage).

3e. 120 VAC ± 10%

4a. 340 Vp-p

4b. No

5. Yes

6a. 340 Vp-p ± 10%

6b. (2) The primary winding of transformer T-1.

6c. Yes

6e. No

8a. No

8b. Yes

10a. 100 Vp-p ± 10%

10c. Yes

11. No

12a. Approximately 3.4 - 1

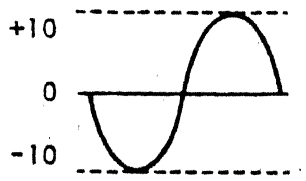
12b. Step-down transformer.

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON III

Power Supply Transformer Secondary Stage

QUESTION NO.	CORRECT ANSWER
1	b
2	b

3



ANSWER SHEET
FOR
JOB PROGRAM
LESSON IV

Power Supply Rectifiers

#26 Low 610Ω High ∞

#27 Low 200Ω High ∞

#28 Low 0Ω High 0Ω

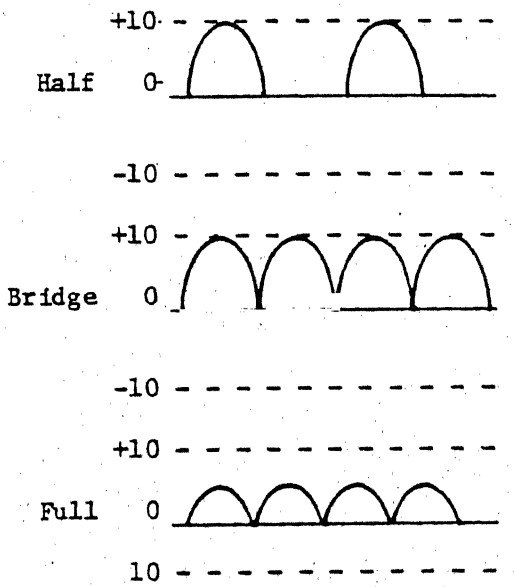
#29 Low 280Ω High ∞

#26, 1: ∞ #27, 1: ∞ #28, 1: 1 #29, 1: ∞

no

ANSWER SHEET
FOR
PROGRESS CHECKS
LESSON IV

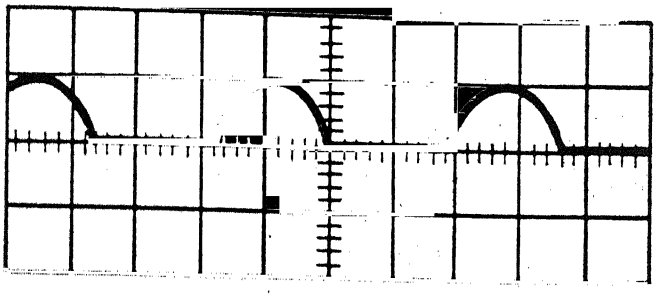
Power Supply Rectifiers

QUESTION No.	CORRECT ANSWER
1.	Full Wave Bridge Half Wave
2.	b
3.	a
4	

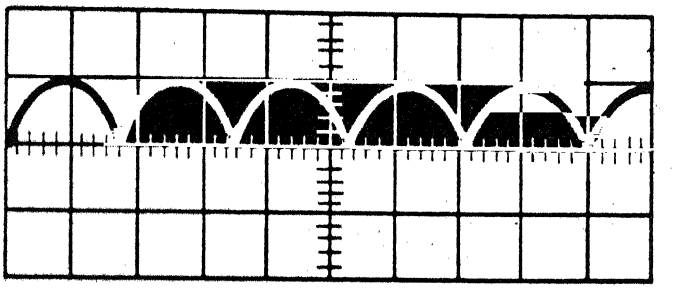
ANSWER SHEET
FOR
JOB PROGRAM
LESSON V

Power Supply Rectifiers and Filters

5. (1) CR1 only

6. 

45 Vp-p ± 10%

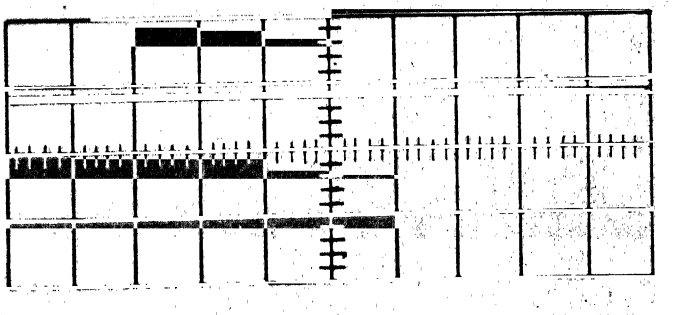
7a. 

45 Vp-p ± 10%

7b. (3) both the positive and negative alternations of the AC input

7c. twice as many

8. 27 VDC ± 10%, .05 DC AMPS ± 10%

11. 

45 VDC ± 10%

12. 43 VDC ± 10% .075 DC AMPS ± 10%
decrease; increase (in that order)

14. Positive side of the C1 must be jumpered to ground to discharge C1.

ANSWER SHEET

FOR

PROGRESS CHECKS

LESSON V

POWER SUPPLY FILTERS

QUESTION NO.	CORRECT ANSWER
1.	b
2.	choke
3.	c
4.	c